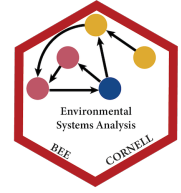


Environmental Systems Analysis

BEE 4750/5750 • Fall 2026



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Course Overview

This is a 3 credit course which is required for the Environmental Engineering major, and can only be taken for a letter grade.

Course Information

Instructor	TA	Meetings
• Vivek Srikrishnan • viveks@cornell.edu • 318 Riley-Robb • TBD	• TBD • TBD • TBD • TBD	• MW • 2:55-4:10pm • 105 Riley-Robb

Course Description

Environmental systems involve multiple interacting processes, uncertainties, and potentially conflicting objectives. These dynamics can complicate analyses which focus on a single component of the system, such as an individual pollution source, or a single outcome of interest. In this course, we will adopt a systems approach to environmental quality modeling and management, including applications in air and water pollution control and solid waste management. In particular, we will:

- define systems and their boundaries;
- identify feedbacks and quantify the stability of systems;
- simulate system dynamics using computer models;
- formulate and solve decision problems for systems management;
- analyze and assess risk;
- make decisions under uncertainty; and
- explore trade-offs across competing objectives.

Learning Outcomes

At the end of this class, students will:

1. Construct mathematical models of environmental systems;
2. Use systems models to simulate dynamics and outcomes;
3. Analyze environmental system risk and vulnerabilities.
4. Determine strategies for managing systems using optimization;
5. Identify the trade-offs that result from competing objectives in environmental decision-making;
6. Evaluate modeled outcomes with respect to model assumptions and limits.

Prerequisites & Preparation

The following courses/material would be ideal preparation:

- **Environmental Processes (BEE 2510 or BEE 2600)**: mass and energy balance, fate and transport
- **Engineering Computation (ENGRD/CEE 3200)**: basic programming, discretization of ODEs, curve fitting
- **One course in probability or statistics (ENGRD 2700, CEE 3040, or equivalent)**: probability, probability distributions, summary statistics

In the absence of one or more these prerequisites, you can seek the permission of instructor.

💡 **What If My Programming or Stats Skills Are Rusty?**

If your programming or statistics skills are a little rusty, don't worry! We will review concepts and build skills as needed. While we will use the Julia programming language in class, if you are familiar with Python or MATLAB, the fundamentals are similar.

Topics

This class will cover the following topics:

- Introduction to environmental systems
- Modeling system dynamics
- Multiple objectives and trade-offs
- Model discretization and simulation
- Uncertainty and Monte Carlo analysis
- Linear programming
- Simulation-optimization
- Decision making under uncertainty
- Sensitivity and robustness

To motivate and illustrate these topics, we will draw on application areas including:

- Climate change
- Water quality
- Air quality
- Electric power systems
- Solid waste management
- Resource allocation
- Reservoir management

Course Philosophy and Expectations

The goal of our course is to help you gain competency and knowledge in the area of environmental systems analysis. This involves a dual responsibility on the part of the instructor and the student. As the instructor, my responsibility is to provide you with a structure and opportunity to learn. To this end, I will commit to:

- provide organized and focused lectures, in-class activities, and assignments;
- encourage students to regularly evaluate and provide feedback on the course;
- manage the classroom atmosphere to promote learning;
- schedule sufficient out-of-class contact opportunities, such as office hours;
- allow adequate time for assignment completion;
- make lecture materials, class policies, activities, and assignments accessible to students.

Students are encouraged to discuss any concerns with me during office hours or through a course communications channel.

Students can optimize their performance in the course by:

- attending all lectures;
- doing any required preparatory work before class;
- actively participating in online and in-class discussions;
- beginning assignments and other work early;
- and attending office hours as needed.

Course Meetings

This course meets MW from 2:55-4:10pm in 105 Riley-Robb. In addition to the class meetings (a total of 27 lectures, 75 minutes each), the final project will be due during the university finals period. Students can expect to devote, on average, 6 hours of effort during the exam period.

Community

Diversity and Inclusion

Our goal in this class is to foster an inclusive learning environment and make everyone feel comfortable in the classroom, regardless of social identity, background, and specific learning needs. As engineers, our work touches on many critical aspects of society, and questions of inclusion and social justice cannot be separated from considerations of systems analysis, objective selection, risk analysis, and trade-offs.

In all communications and interactions with each other, members of this class community (students and instructors) are expected to be respectful and inclusive. In this spirit, we ask all participants to:

- share their experiences, values, and beliefs;
- be open to and respectful of the views of others; and
- value each other's opinions and communicate in a respectful manner.

Please let me know if you feel any aspect(s) of class could be made more inclusive. Please also share any preferred name(s) and/or your pronouns with me if you wish: I use he/him/his, and you can refer to me either as Vivek or Prof. Srikrishnan.

Please be professional and courteous on all course interactions and platforms, and (except in designated off-topic boards or forums) please keep all online discussion relevant to the course. We do not anticipate this as a problem given our experience; almost all students in almost all classes meet these expectations. However, even a single incident can do serious damage to the learning environment and the well-being of your fellow students.

Sexually explicit, harassing, threatening, bullying, trolling, racist, sexist, homophobic, transphobic, or otherwise grossly unprofessional content will be removed. Anyone behaving in these fashions or posting such content will be blocked/banned from the appropriate platform and may be given an F if they are consistently disruptive.

We have configured our Ed Discussion board to allow anonymous posts; we will restrict posts to real names only if anyonymous posts become problematic.

! Please, Be Excellent To Teach Other

We all make mistakes in our communications with one another, both when speaking and listening. Be mindful of how spoken or written language might be misunderstood, and be aware that, for a variety of reasons, how others perceive your words and actions may not be exactly how you intended them. At the same time, it is also essential that we be respectful and interpret each other's comments and actions in good faith.

Student Accomodations

Let me know if you have any access barriers in this course, whether they relate to course materials, assignments, or communications. If any special accomodations would help you navigate any barriers and improve your chances of success, please exercise your right to those accomodations and reach out to me as early as possible with your [Student Disability Services](#) (SDS) accomodation letter. This will ensure that we have enough time to make appropriate arrangements.

If you need more immediate accommodations, but do not yet have a letter, please let me know and then follow up with SDS.

Course Communications

Most course communications will occur via [Ed Discussion](#). Public Ed posts are generally preferred to private posts or emails, as other students can benefit from the discussions. If you would like to discuss something privately, please do reach out through email or a private Ed post (which will only be viewable by you and the course staff).

Announcements will be made on the course website and in Ed. Emergency announcements will also be made on Canvas.

! Ed Tips

- **Do not take screenshots of code.** I will not respond. Screenshots can be difficult to read and limit accessibility. Put your code on GitHub, share the link, and point to specific line numbers if relevant, or provide a *simple*, self-contained example of the problem you're running into.
- If you wait until the day an assignment is due (or even late the previous night) to ask a question on Ed, there is a strong chance that I will not see your post prior to the deadline.
- If you see unanswered questions and you have some insight, please answer! This class will work best when we all work together as a community.

Mental Health Resources

We all have to take care of our mental health, just as we would our physical health. As a student, you may experience a range of issues which can negatively impact your mental health. Please do not ignore any of these stressors, or feel like you have to navigate these challenges alone! You are part of a community of students, faculty, and staff, who have a responsibility to look for one another's well-being. If you are struggling with managing your mental health, or if you believe a classmate may be struggling, please reach out to the course instructor, the TA, or, for broader support, please take advantage of [Cornell's mental health resources](#).

! Mental Health And This Class

I am not a trained counselor, but I am here to support you in whatever capacity we can. You should never feel that you need to push yourself past your limits to complete any assignment for this class or any other. If we need to make modifications to the course or assignment schedule, you can certainly reach out to me, and all relevant discussions will be kept strictly confidential.

Course Policies

Many policies below (including grading policies) are broken out and discussed further on the course website. Lack of familiarity with any of these policies is not an excuse for violating any of them.

Attendance

Attendance is not *required*, but in general, students who attend class regularly will do better and get more out of the class than students who do not. Your class participation grade will reflect both the quantity and quality of your participation, only some of which can occur asynchronously. I will put as many course materials, such as lecture notes and announcements, as possible online, but viewing materials online is not the same as active participation and engagement. Life happens, of course, and this may lead you to miss class. Let me know if you need any appropriate arrangements ahead of time.

! What If I'm Sick?

Please stay home if you're feeling sick! This is beneficial for both for your own recovery and the health and safety of your classmates. We will also make any necessary arrangements for you to stay on top of the class material and if whatever is going on will negatively impact your grade, for example by causing you to be unable to submit an assignment on time.

Mask Policies

Please stay home and rest if you have symptoms of COVID-19 or any other respiratory illness. No masking will be required, but please be respectful of others who may wear masks or take other precautions to avoid illness. This policy may change if there is another outbreak of COVID-19 (or other illness), but will be kept consistent with broader Cornell mask policies.

Academic Integrity**! Important**

TL;DR: Don't cheat, copy, or plagiarize!

This class is designed to encourage collaboration, and students are encouraged to discuss their work with other students. However, I expect students to abide by the [Cornell University Code of Academic Integrity](#) in all aspects of this class. **All work submitted must represent the students' own work and understanding**, whether individually or as a group (depending on the particulars of the assignment). This includes analyses, code, software runs, and reports. Engineering as a profession relies upon the honesty and integrity of its practitioners (see e.g. the [American Society for Civil Engineers' Code of Ethics](#)).

External Resources

The collaborative environment in this class **should not be viewed as an invitation for plagiarism**. Plagiarism occurs when a writer intentionally misrepresents another's words or ideas (including code!) as their own without acknowledging the source. **All** external resources which are consulted while working on an assignment should be referenced, including other students and faculty with whom the assignment is discussed. You will never be penalized for consulting an external source for help and referencing it, but plagiarism will result in a zero for that assignment as well as the potential for your case to be passed on for additional disciplinary action.

AI/ML Resource Policy

Large language models (LLMs), such as GPT, and other generative AI models are powerful tools for predicting text and code patterns. However, while they can save time (though you'd be surprised at how little time their careful use saves), they often make mistakes that can be hard to detect or fail to communicate key ideas or insights at the expense of more general and banal text. As you are likely to encounter an ever-widening use of these tools when you leave Cornell, it is critical that you learn how to use these tools responsibly and effectively.

However, this class will not focus on teaching you how to use LLMs responsibly; we assume that if you are using these tools, you are doing so in a way which benefits your learning and helps you communicate your already-existing understanding, rather than substituting for it. You are **generally** permitted to use these tools, but you are ultimately responsible for guaranteeing, understanding, and interpreting your results. If you submit work that was LLM generated, and this work receives a poor grade due to the LLM's inability to demonstrate understanding, your grade will reflect that substantive assessment.

General guidelines for AI/ML use:

- **AI tools for code:** You may use LLM tools for code development and debugging, particularly for translating between other languages that you already have a better knowledge of (e.g. Python) and Julia. However, LLMs often make bad decisions about how to structure code, can introduce bugs (including suggesting packages that do not exist or outdated syntax), and can mislead you about what your code is doing. You are responsible for understanding and debugging any code involved in solving computational exercises. Notably, if you ask for help debugging LLM-generated code, this will not be possible unless you have already developed your own understanding of what each piece of the code does (or should do) and which parts work and don't work.
- **AI tools for writing:** LLMs **should not be used to generate text that you submit as your own work.** The point of written assessments (including model derivations and interpretations) is to stimulate your own critical thinking and mathematical skills, and you short-cut this process by substituting LLM use for your own process of formulating and articulating ideas. Even using LLMs to do the initial writing and editing that output will result in shallower thinking. As we are not teaching you in this class to critically engage with LLMs, However, you *may* use LLMs or similar tools (e.g. Grammarly) to help you edit your writing. As mentioned before, you are ultimately responsible for the content of any work you turn in: if a tool used to edit grammar changed the substance of your writing, you will be responsible for the submission.

To distinguish between these permissible and impermissible uses, you are required to cite your use of the tool (as with any other external reference). In particular, you must disclose how you use the LLM and how you incorporated any output into your final submission. **Failure to fully reference the interaction, as described above, will be treated as plagiarism and referred to the University accordingly.** If you have any questions about whether your planned use of an AI/ML tool complies with the academic integrity policy, please consult a member of the course staff ahead of its use.

Late Work Policy

In general, late work can be submitted up to 24 hours late at a 50% penalty, and will not be accepted after that point. This policy may seem strict, but allows for prompt release of solutions and discussion of assignments. Please reach out *as soon as possible* (ideally before the due date) if legitimate circumstances emerge which prevent you from submitting work within 24 hours of the due date; we will make accommodations for approved reasons, which might include a limited extension or dropping the assignment.

Regrade Requests

Regrade requests can be submitted up to one week after the graded work is released on Gradescope.

All regrade requests must include a **brief** justification for the request or they will not be considered. Good justifications include (but are not limited to): - *My answer agrees with the posted solution, but I still lost points.* - *I lost 4 points for something, but the rubric says it should only be worth 2 points.* - *You took points off for something, but it's right here.* - *My answer is correct, even though it does not match the posted solution; here is an explanation.* - *There is no explanation for my grade.* - *I got a perfect score, but my solution has a mistake (you will receive extra credit for this! see below!)* - *There is a major error in the posted solution; here is an explanation (full credit for everyone, but Prof. Srikrishnan will decide what constitutes a "major error"! see below!).*

! We Can Only Grade What You Submitted

All regrades will be assessed based only on the submitted work. You cannot get a higher grade by explaining what you meant (either in person or online) or by adding information or reasoning to what is submitted after the

fact. The goal of the regrade is to draw attention to a potential grading problem, not to supplement the submission.

The first regrade request for any submission will be handled by the person who graded that homework problem. The first regrade request for any exam submission will be handled by whoever graded that exam problem. If the submission was graded by the TA, additional regrade requests for the same submission will be handled directly by the instructor. Once Prof. Srikrishnan issues a final response to a regrade request, further requests for that submission will be ignored.

⚠️ Regrade Requests Can Be A Gamble!

While you should submit regrade requests for legitimate errors, using them for fishing expeditions can also result in lost points if the TA or Prof. Srikrishnan decide that your initial grade was too lenient or if additional errors are identified.

💡 What If I Find A Different Type of Mistake?

- If you submit a regrade request *correctly* reporting that a problem was graded too leniently — that is, that your score was higher than it should be based on the rubric — your score will be increased by the difference. For example, if your original score on a problem was 8/10 and you successfully argue that your score should have been 3/10, your new score will be 13/10. However, don't fish — your grade might be lowered if the TA finds an independent mistake while regrading.
- If a significant error is discovered in a posted homework solution or in the exam solutions, everyone will in the class will receive *full* credit for the (sub)problem. Prof. Srikrishnan will decide what is "significant".

Office Hours

Office hours with both Prof. Srikrishnan and the TA will be available each week at times specified at the top of this syllabus. Changes to the office hour schedule (cancellations/rescheduling) will be announced in class and on Ed Discussion.

Office hours are intended to help all students who attend. This time is limited, and is best spent on issues that are relevant to as many students as possible. While we will do our best to answer individual questions, students asking us to verify or debug homework solutions or help with syntax will have the lowest priority (**but please do ask about how to verify or debug your own solutions!**). However, we are happy to discuss conceptual approaches to solving homework problems, which may help to reveal bugs.

Space at office hours can be limited (we may shift to the conference room in 316 Riley-Robb if offices are full and it is available). If the room is crowded and you can find an alternative source of assistance, or if your question is low priority (e.g. debugging) please be kind and make room for others.

💡 What If I Can't Make Office Hours?

While we will try to select office hours that work for as much of the class as possible, both the course staff and students have busy schedules and no time will work for everyone. **If you need help outside of office hours (e.g. office hours do not fit your schedule), please send an email to the TA or Prof. Srikrishnan as soon as possible.** These requests may not be accepted on short notice (e.g. if you have a question about a homework due on Thursday and send a request on the immediately prior Wednesday; schedules for course staff may already be full). We recommend starting your homework promptly so you can take advantage of office hours or make an appointment over a longer period.

Assessments

Your grade will be computed as the weighted average of the following assessment categories:

Category	Weight
Labs	10%
Homework	15%
Mini-Projects	20%
Quizzes	30%
Term Project	25%

i Will There Be a Curve?

Grades on individual assessments will not be curved. It is unlikely that the final grades will be adjusted, but we may apply a curve **if and only if** circumstances arise which would make this appropriate, such as if the exams turn out to be longer or more difficult than intended. Grades will not be curved to meet any pre-defined distribution; it is entirely possible that everyone earns an A or everyone earns an F. Asking about a curve will not make one more likely.

Labs

Approximately 4 class periods will be dedicated to working through simple examples to guide you through applying concepts and methods from class. Students should bring their laptops to class, and will be given a worksheet to complete (as much as they can) during these lab classes. Labs will be designed to be completed in class, though you may occasionally require additional time; however, lab worksheets must be submitted by 9:00pm on the day after the lab day. As a result, I encourage you to make sure that you download and set up the lab materials ahead of time; these will be provided for you on Ed Discussion. Labs will be graded on a scale of 0-3 on the basis of effort towards demonstrated work, rather than absolute correctness or completion. No labs will be dropped by default. If you cannot bring a laptop to class, you can work with other students, though you must turn in your own worksheet for grading.

Homework

Approximately 8-10 homework assignments will be assigned throughout the semester. The homework assignments are problem sets combining mathematical derivations and analysis and small computational exercises building on the examples and methods from class. You will generally have one class week to work on an assignment.

Students are encouraged to collaborate and learn from each other on homework assignments, and groups of up to three students can submit a single group homework solution. Students are responsible for forming their own homework groups, which can differ for each assignment. Only one student from a group should submit a solution, and it is the responsibility of the student submitting the assignment to tell Gradescope the names of the other group members. Otherwise, if multiple solutions from the same group are submitted, only one will be graded (whichever first comes up in Gradescope) and the rest ignored.

Consulting and referencing external resources and your peers is encouraged (engineering is a collaborative discipline!), but plagiarism is a violation of academic integrity.

Some notes on assignment and grading logistics:

- Homework assignments will be distributed using GitHub Classroom. While GitHub use is not required for the class aside from accepting and cloning assignments, students are encouraged to update their GitHub repositories as they work on the assignments; this helps with answering questions, keeping solutions

synced across groups, and gives you a backstop in case something goes wrong and you can't submit your assignment on time.

- Homeworks are due by 9:00pm Eastern Time on the designed due date (usually a Thursday). Your assignment writeup should be submitted to Gradescope as a PDF with the answers to each question tagged (a failure to do this will result in a non-negotiable 10% point deduction). **All students in a group are responsible for ensuring that the student who submits the assignment for their group tags each question, as all will have points deducted if this is not done.**
- A meta-rubric is provided on the website, under the Homework page. These are not customized for each assignment but the principles will apply generally.
- One homework assignment will be dropped by default. You can turn in assignments within 24 hours of the due date with a 50% penalty. If you need a further accommodation for a particular assignment, talk to Prof. Srikrishnan **before the due date**. Requests for extensions made after the due date will only be considered under extraordinary and unexpected circumstances. Technical challenges submitting assignments are not acceptable reasons for extensions to be granted, and late penalties will apply.
- **Your submitted homework must stand on its own***! We cannot grade you on the basis of information which was not included in the submitted assignment. While regrade requests should include a justification for why your grade is incorrect, we will not consider explanations or additional reasoning outside of the submission.

Mini Projects

There will be 2-3 more in-depth computational projects assigned throughout the semester which will require students to apply multiple methods from the course to a particular systems problem. These projects will typically involve the formulation and analysis of a mathematical model for the system of question and will involve the preparation of a short report justifying the model formulation, outlining the methods, and presenting and interpreting results. Students in BEE 4750 will be able to work in groups of 2 and should submit a group report following the homework guidelines, while students in BEE 5750 must work independently.

Quizzes

Approximately 5-6 quizzes will be given in-class. These will be in the first part of the relevant class, approximately 25 minutes long. No materials (books, notes, computers, or calculators) are allowed. Quizzes will be scanned into Gradescope for grading. The material which will be covered on the quiz will be specified ahead of time in class or on Ed Discussion. No quizzes will be dropped for students in BEE 5750, but one quiz will be dropped for students in 4750.

Term Project

This course will culminate with a term project. The goal of this project is to apply and extend the tools and approaches we will learn in class to an application of your choosing. While we encourage drawing on other classes or interests when developing and working on your project, **submitting work from another course or work which was completed prior to the course is not permitted.**

The term project will be completed in groups (3-4 students). Graduate students enrolled in BEE 5750 may work on individual projects, but are not required to do so. The final deliverable for this project will be a report summarizing the project and results, including a section detailing research you have conducted on relevant regulations and how they were incorporated into your project. Ahead of that, you will submit the following a proposal for feedback on the scope of your project as well as a description of task coordination.

The project will be assessed on the basis of both group and individual components:

1. **Group** (80 points):

1. (10 points) **Proposal:** Groups will develop a proposal for their final project, which will include two main components. The first is a research plan, which should (succinctly) describe the background for the problem and articulate the key question (system overview, model specification) as well as providing a brief overview of proposed methods (data sources, planned analytic approach). The second is a work plan, which will include task assignments across group members, deadlines for interim tasks, and a plan for coordination (meeting frequency, materials sharing, etc).
2. (20 points) **Presentation:** Groups will present their projects to the class at the end of the semester. Due to time restrictions, these may be recorded and uploaded to Canvas if there are too many projects for the time available. Presentations should be no more than 10 minutes long and should be aimed at a general audience.
3. (10 points) **Peer Review:** Each group will be asked to provide a peer review on two of their classmates' presentations. The format for the review will be made available on the class website.
4. (40 points) **Final Report:** Each group will submit a 3-5 page final report aimed at an engineering audience. Instructions will be provided with detailed expectations.

2. **Individual** (20 points):

1. (5 points) **Self-Assessment:** Each individual in a group will submit a short self-assessment of their project, including a description of the work they contributed to the project (< 1/2 page) and reflections on what worked well or less well (< 1/2 page).
2. (15 points) **Peer Evaluation:** Each individual in a group will submit an evaluation of their teammates' contributions to the final project and the group dynamic, including assessments of participation, work quality, and inclusivity. Points will be awarded based on the evaluations from your group; different scales will be applied for undergraduate (4750) and graduate (5750) students. *No points will be given for any student who fails to submit evaluations for their groupmates.*

The term project will be due during the university finals period, at a date and time assigned by the Office of the University Registrar. In addition to work completed during the semester, students can expect to devote approximately 6 hours to the term project during the exam period.

Grading

Grading Scale

The following grading scale will be used to convert the numerical weighted average from the assessments (above) to letter grades.

Grade	Range
A+	97–100
A	93–97
A-	90–93
B+	87–90
B	83–87
B-	80–83
C+	77–80
C	73–77

Grade	Range
C-	70–73
D+	67–70
D	63–67
D-	60–63
F	< 60

We reserve the right to lower these cutoffs as appropriate, but will not raise them from these levels.

i Will You Round Up or Curve My Grade?

Grades **may** be rounded up if they are just below the cutoff, but this is not a given, and requests for grade round-ups will be ignored. For example, you should assume that a score of 92.9% has missed the A cutoff of 93% (it is, after all, below the cutoff). Consider it a pleasant surprise if the round-up is given.

While final grades will **not** be curved, individual assessments (mainly exams) may be curved if they prove to be more difficult than intended, but this will not be with a view towards achieving a particular grade distribution.

Forgiven Assignments

Forgiven assignments (due to extenuating circumstances, ***discussed with and approved by Prof. Srikrishnan***) will be treated as though they do not exist, and the appropriate grading component will be computed without them. This does mean that e.g. submitted homeworks will carry more weight in the overall grade computation. In exceptional cases, we will compute course grades based entirely on exams.

Exceptions

We reserve the right to give any student meeting at least one of the following conditions an automatic F:

1. Overall exam average below 25%;
2. Submitted less than half of the assigned homework problems;
3. Extremely low levels of participation and effort.

This should not generally be a concern; students putting in a good faith effort by attending class, participating in online discussions, doing most of the work, and taking the exams will not be at risk of this policy.